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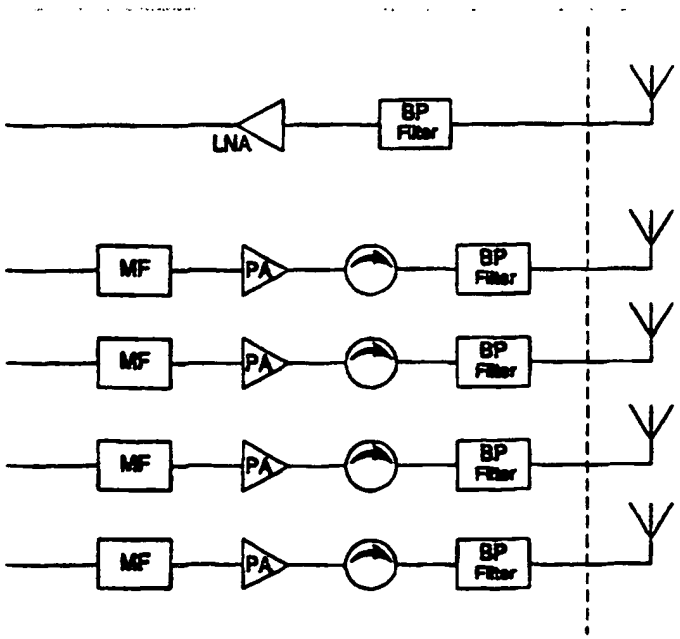
(54) Title: CHANNEL-SELECTIVE REPEATER FOR MOBILE TELEPHONY

(57) Abstract

In a channel-selective repeater, signals are received from the receiver antennas in order to be selected and amplified in each of their own frequency channels. According to the invention, the amplified signals are led from the power amplifier (PA) of the channels via isolators and filters to each of their own antennas in an antenna arrangement. Preferably, the antennas are patch-antennas and the amplifiers built and connected via microstrip technology.



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Channel-selective repeater for mobile telephony

The invention relates to a channel-selective repeater for mobile telephony in accordance with the preamble of claim 1.

In cellular mobile telephone systems there are necessarily regions present within the cells with such poor receiving conditions in relation to their base stations that one must speak about a radio shadow. This can concern underground large parking garages or the like, but also obstacles of a natural type, buildings etc., where the use of a repeater would be the natural way to fit the region into its natural cell.

Figure 1 shows a block diagram of such a known channel-selective repeater which in such a diagram is represented as being symmetrical, and wherein after the respective low-noise amplifiers LNA, damping circuits ATT and distributors PD only one channel circuit is drawn, terminating with a power amplifier PA and an isolator circuit, the output of which is connected to a combiner PC, which adds the different transmitter signals for transmission via a duplex filter via the antenna. The same duplex filter picks up the transmitter signals to the other branch in the diagram. In Figure 2 it is shown how the different channels, four here, through the final amplifier outputs are led to the combiner, here comprising the isolation circuits.

The reason for arranging channel separation for processing in the repeater is that there are extremely high requirements for linearity in order to avoid interference in the form of intermodulation products which mobile telephone systems are extremely sensitive to.

At the same time the same requirement for linearity means that known combiners in order to fulfill the requirements cannot have a high efficiency - one can count on 7 dB losses (theoretically at least 6 dB) for a combiner. In addition there are filter losses of around 0.5 dB and cable losses of 2.5 dB between the final amplifier in the respective cable and antenna. The output power P from the antenna in that connec-

tion requires the out-put power 10 P from the final amplifier. This increases the cost for the amplifier and the power supply, and furthermore a special cost arises for cooling away the waste power.

It is therefore an object of the invention to provide a more economical and advantageous channel-selective repeater for mobile telephony.

This and other objects are achieved according to the invention by elaborating a channel-selective repeater of the type mentioned in the introduction in accordance with the features which are stated in the characterizing part of claim 1.

A particularly advantageous constructive embodiment of the invention is obtained if the transmitting antennas are designed as patch antennas. This also permits an integrated design.

Advantageous embodiments are clear from the subclaims.

For a closer explanation of the idea of patch-antennas reference is made to the document of James & Hall: Microstrip Antenna Theory and Design (1981), which herewith is declared to be incorporated by reference in the present description.

The invention will now be more closely explained in connection with an embodiment and the Figures. Figure 1, already described, shows a block diagram of a known channel-selective repeater. Figure 2, also described earlier, shows in more detail the combination of the output signals from the separate channels. Figure 3 shows in the form of a block diagram an antenna connection according to the principles of the invention. Figure 4 shows an antenna system according to a preferred embodiment of the invention. Figure 5 shows a way of increasing the isolation between the antennas. Figure 6 illustrates another method for separating the channels.

In accordance with the invention the combiner in a repeater is eliminated at least on the side which is directed towards the region of radio shadow, which transmits towards the mobile stations. For the side which are directed towards a base station it is sometimes possible to use directional antennas with such antenna amplification that only small quantities of power are required so that the disadvantages of a combiner become less. On the other side, a construction of one antenna per transmitting channel and a common receiver antenna could be suitable for both ends of a divided repeater.

Figure 3 shows how the different channels after separation and filtering (in BP in Figure 1 resp. MF in Figure 3) are amplified in each of their amplifiers PA. After passing through an isolator and a bandpass filter the signals each go to their own antenna.

The combination of the transmitter powers for the different channels thus takes place according to the invention in the air, and one thereby avoids non-linear elements as in the air no intermodulation occurs.

According to a preferred embodiment a plate with patch antennas is used as an antenna arrangement, one for receiving M and a number of transmitter antennas S corresponding to the number of channels. An example is evident from Figure 4, where the patch antennas, rectangular metal plates, are mounted on a plate with good high-frequency characteristics. Their width is approximately half the wave length, their length somewhat greater. The emissions are approximately dipole-like and polarized. The feeding takes place from the rear side whereby the choice of connection points determines the adjustment. Suitably the filters, amplifiers, isolators, etc. are arranged behind the plate, preferably to a large part in microstrip technique or the like, and the plate is completed on the underside with a protective casing.

This embodiment permits a much easier and more flexible installation than known repeaters.

A precondition for a good functioning of the invention is that the isolation between the antennas is sufficiently good. It can in this case be suitable, with patch-antennas, to let the transmitter antennas have a mutual distance of half the wave length (in air) or more.

It is possible, not only with patch-antennas, if such would be necessary, to have a further improvement by damping and phase rotating according to Figure 5. If an antenna receives a weak signal from the other via the air, then this can be compensated for with a 180 degrees phase-displaced signal with the same amount.

It is also possible to avoid mutual influence through arranging the transmitter antennas with different polarisation directions. An example thereof with patch-antennas is shown in Figure 6, where the patch-antennas S are lengthened in four different directions. Through feeding the patch-antennas from different sides the different polarisation directions can also be achieved.

Through the invention an economical repeater is obtained which can be given a higher output power and thereby greater area of coverage. The current consumption can be reduced, likewise the requirements for cooling. Higher MTBF and higher linearity can be guaranteed.

Claims

1. Channel-selective repeater for mobile telephony, with a first antenna arrangement for placing within communication range of a base station and a second antenna arrangement for transmitting/receiving in an area difficult to reach from the base station, which antenna arrangements both are intended for both transmitting and receiving, whereby a signal received by an antenna arrangement is divided into its individual frequency selective channel in order to, after being amplified, be transmitted, signals received by the first antenna arrangement via the second antenna arrangement, and vice versa, **characterized** in that at least the signals transmitted via the second antenna arrangement are led amplified thereby from their respective selective channels to their own separate transmitter antenna and combined in the air.

2. Channel-selective repeater according to Claim 1, **characterized** in that both the first and the second antenna arrangements have the same number of transmitter antennas as selective channels.

3. Channel-selective repeater according to Claim 1 or 2, **characterized** in that the separate transmitter antennas are patch-antennas.

4. Channel-selective repeater according to Claim 3, **characterized** in that the separate transmitter antennas are mounted on a common plate together with a receiver antenna.

5. Channel-selective repeater according to Claim 4, **characterized** in that the plate is a laminate with good high-frequency characteristics and that behind the plate are mounted amplifier circuits belonging to the antennas, the output conductors of which via isolator circuits are drawn through the laminate to the respective patch-antennas and joined at points thereof which correspond to the output-adapted resistance of the respective circuits.

6. Channel-selective repeater according to any of the previous claims, **characterized** in that between pairs of transmitter antennas are arranged networks with a 180° phase shifter and a damping circuit in series, in order to eliminate the influence of interaction.

5

7. Channel-selective repeater according to any of Claim 4 or 5, **characterized** in that the transmitter antennas are mounted with their polarisation directions mutually rotatingly displaced in order to eliminate the influence of interaction.

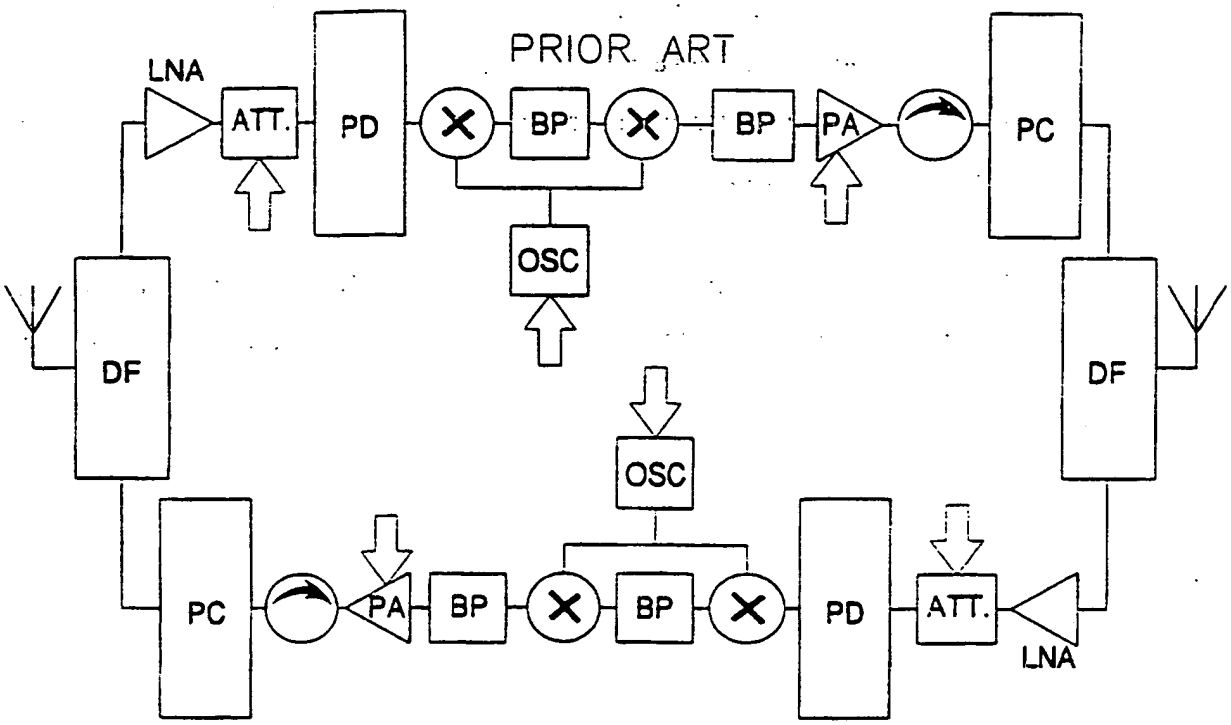
PRIOR ART
LNA
ATT.
PD
BP
BP
PA
PC
OSC
DF
DF
OSC
PC
PA
BP
BP
PD
ATT.
LNA

FIG.1

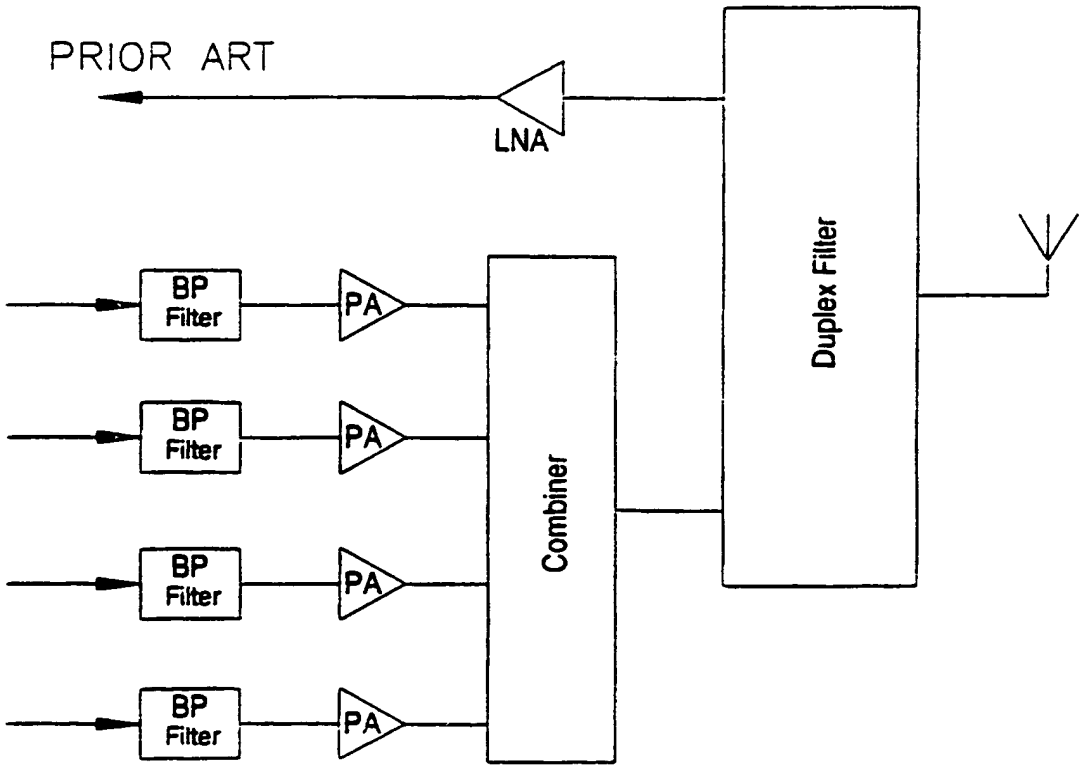
PRIOR ART
LNA
Duplex Filter
BP Filter
PA
BP Filter
PA
BP Filter
PA
BP Filter
PA
Combiner

FIG.2

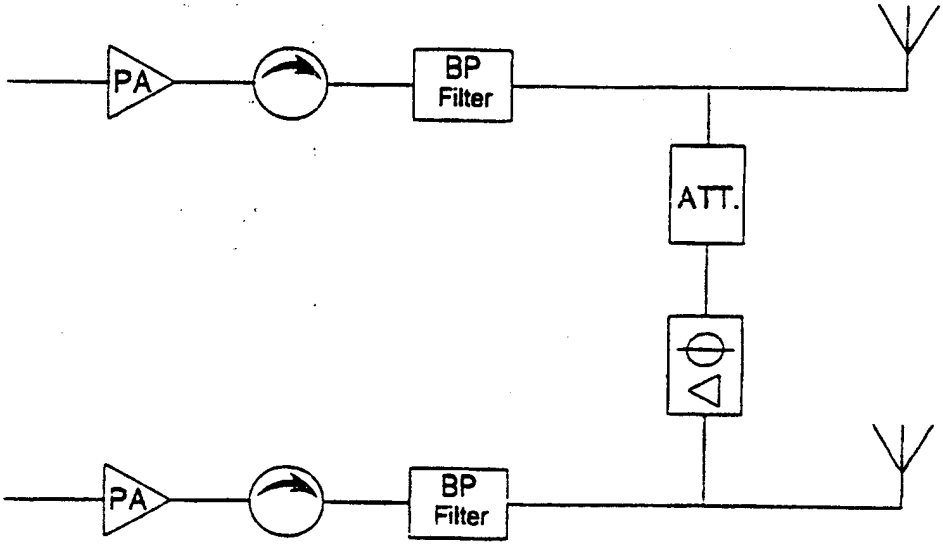

FIG.5

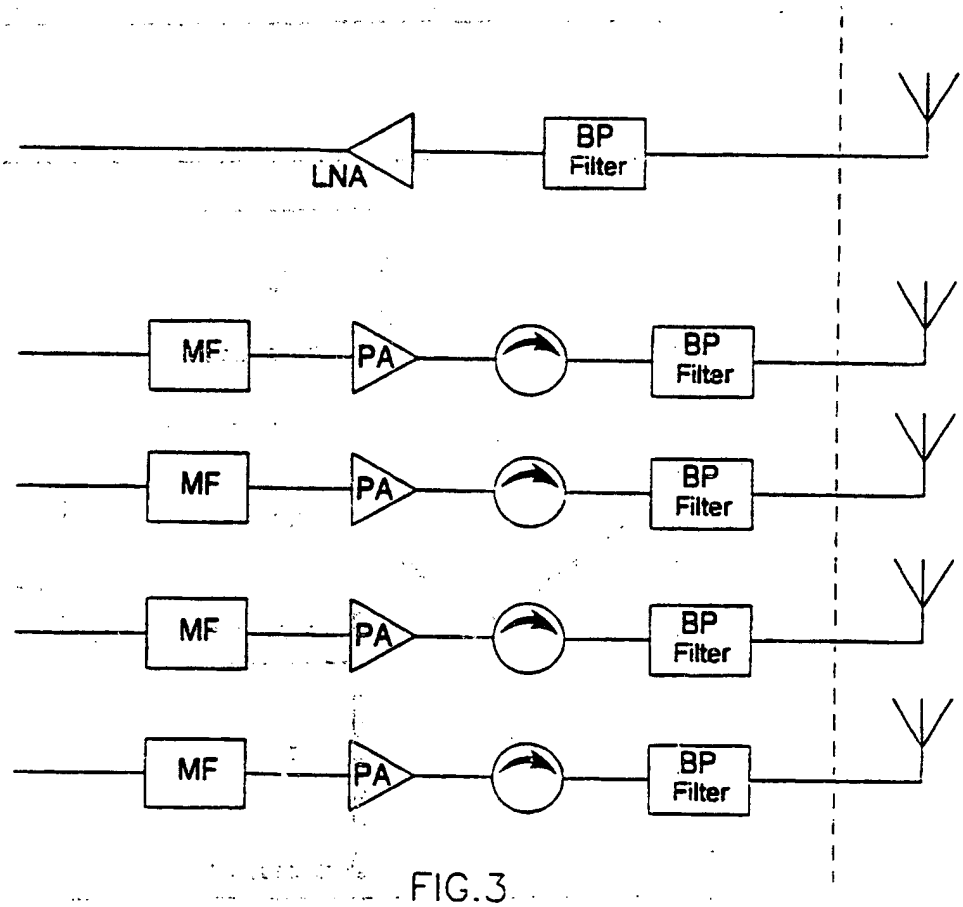

FIG.3

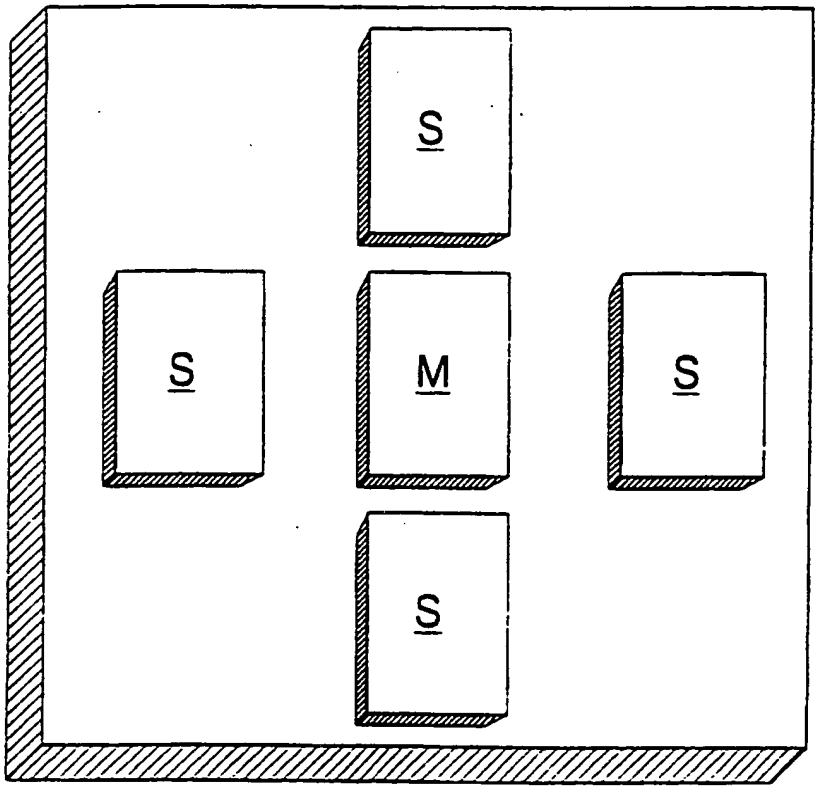

FIG.4

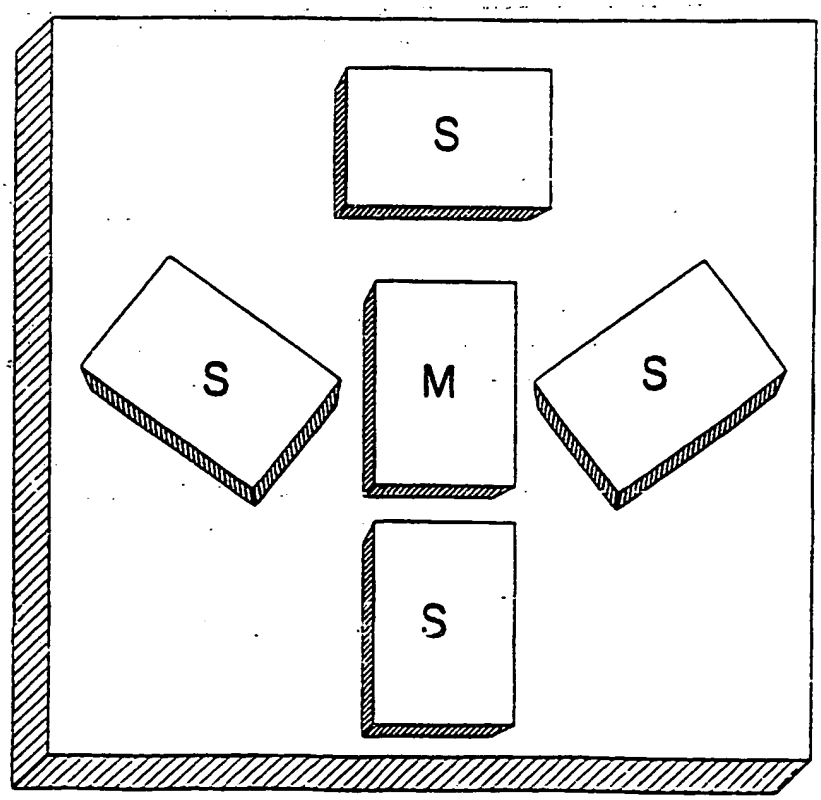

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/00739

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9518492 A1 (NOOS SPACE TECHNOLOGIES LTD.), 6 July 1995 (06.07.95), abstract --	1-7
A	GB 2167626 A (RAYTHEON COMPANY(USA-MASSACHUSETTS)), 29 May 1986 (29.05.86), see whole document --	1-7
A	GB 2266028 A (USW PCN INC), 13 October 1993 (13.10.93), see whole document --	1-7
P,A	US 5625365 A (PAUL K.W. TOM ET AL), 29 April 1997 (29.04.97), see whole document -- --------	1,7

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9518492 A1	06/07/95	RU 2054804 C	20/02/96
GB 2167626 A	29/05/86	DE 3541239 A	28/05/86
		US 4806938 A	21/02/89
GB 2266028 A	13/10/93	NONE	
US 5625365 A	29/04/97	NONE	

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